

Claims

What is claimed is:

1. A negative photoresist composition, comprising:

(a) a radiation sensitive acid generator;

(b) a multihydroxy-containing additive having the structure:

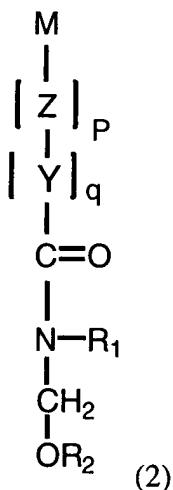
$Q-(OH)_m$, (1)

wherein Q is one of an aliphatic group with 2 to 60 carbons, an aromatic group with 6 to 60 carbons, a semi- or perfluorinated aliphatic group with 2 to 60 carbons, a semi- or perfluorinated aromatic group with 6 to 60 carbons; and

wherein m is an integer from 2 to 6; and

(c) a resist polymer comprising a first repeating unit from a first monomer,

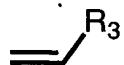
wherein the first monomer has the structure:



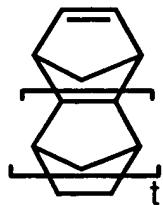
wherein M is a polymerizable backbone moiety,

wherein Z is a linking moiety comprising one of -C(O)O-, -C(O)-, -OC(O)-, -O-C(O)-C(O)-O-,
wherein Y is one of an alkylene group, an arylene, a semi- or perfluorinated alkylene group, and a semi- or perfluorinated arylene group,
wherein p and q are independently 0 or 1,
wherein R₁, and R₂ independently comprise one of hydrogen and a straight or branched alkyl group with 1 to 6 carbons,
wherein the resist polymer is soluble in an aqueous alkaline developer solution,
wherein the acid generator is adapted to generate an acid upon exposure to imaging radiation characterized by a wavelength, and
wherein the resist polymer is adapted to chemically react with the additive in the presence of the acid to generate a product that is insoluble in the developer solution.

2. The composition of claim 1, wherein Q includes at least one cyclic structure.
3. The negative photoresist composition of claim 1, wherein Q comprises at least one alicyclic structures.
4. The negative photoresist composition of claim 1, wherein the polymerizable backbone moiety, M, includes one of an acrylic structure and a cyclic olefinic structure, wherein the acrylic structure is:



wherein R₃ represents one of hydrogen, an alkyl group of 1 to 20 carbons, a semi- or perfluorinated alkyl group of 1 to 20 carbons, and CN, and wherein the cyclic olefinic structure is:



wherein t is an integer from 0 to 3.

5. The composition of claim 1, wherein the resist polymer further comprises a second repeating unit from a second monomer, and wherein the second monomer has an aqueous base soluble moiety.

6. The composition of claim 6, wherein the second monomer comprises one of a fluorosulfonamide, a carboxylic acid, and a fluoroalcohol.

7. The composition of claim 1, wherein the acid generator comprises at least one of 4-(1-butoxynaphthyl) tetrahydrothiophenium perfluorobutanesulfonate, triphenyl sulfonium perfluorobutanesulfonate, t-butylphenyl diphenyl sulfonium perfluorobutanesulfonate, 4-(1-butoxynaphthyl) tetrahydrothiophenium perfluorooctanesulfonate, triphenyl sulfonium

perfluorooctanesulfonate, t-butylphenyl diphenyl sulfonium perfluorooctanesulfonate, di(t-butylphenyl) iodonium perfluorobutane sulfonate, di(t-butylphenyl) iodonium perfluorohexane sulfonate, di(t-butylphenyl) iodonium perfluoroethylcyclohexane sulfonate, di(t-butylphenyl) iodonium camphoresulfonate, and perfluorobutylsulfonyloxybicyclo[2.2.1]- hept-5-ene-2,3-dicarboximide.

8. The negative photoresist composition of claim 1, further comprising at least one of a solvent and a quencher.

9. The negative photoresist composition of claim 8, wherein the solvent comprises at least one of an ether, a glycol ether, an aromatic hydrocarbon, a ketone, an ester and combinations thereof.

10. The negative photoresist composition of claim 8, wherein the quencher is selected from the group consisting of aromatic amines, aliphatic amines and combinations thereof.

11. The composition of claim 8, wherein a weight percent of the polymer is from about 1 weight percent to about 30 weight percent of the weight of the composition; a weight percent of the solvent is from about 70% to about 99% of the weight of the composition; wherein a weight percent of the multihydroxy-containing additive is from about 1 weight percent to about 30 weight percent of the weight of the polymer; wherein a weight percent of the acid generator is from about 0.5 weight percent to about 20 weight percent of the weight of the polymer; and wherein a weight percent of the quencher is from about 0.1 weight percent to about 2.0 weight percent of the weight of the polymer.

12. The composition of claim 8, wherein a weight percent of the polymer is from about 5 weight percent to about 15 weight percent of the weight of the composition; a weight percent of the solvent is from about 85% to about 95% of the weight of the composition; wherein a weight percent of the multihydroxy-containing additive is from about 1 weight percent to about 15 weight percent of the weight of the polymer; wherein a weight percent of the acid generator is from about 0.5 weight percent to about 15 weight percent of the weight of the polymer; and wherein a weight percent of the quencher is from about 0.1 weight percent to about 1.0 weight percent of the weight of the polymer.

13. A method of patterning a substrate, said method comprising the steps of:

(A) applying a negative photoresist composition to the substrate to form a resist layer on a material layer of the substrate and in direct mechanical contact with the material layer, said composition comprising:

(a) a radiation sensitive acid generator,

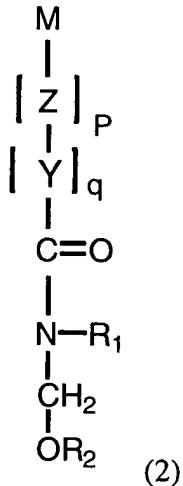
(b) a multihydroxy-containing additive having the structure:

$Q-(OH)_m$, (1)

wherein Q is one of an aliphatic group with 2 to 60 carbons, an aromatic group with 6 to 60 carbons, a semi- or perfluorinated aliphatic group with 2 to 60 carbons, a semi- or perfluorinated aromatic group with 6 to 60 carbons; and

wherein m is an integer from 2 to 6; and

(c) a resist polymer comprising a first repeating unit from a first monomer, wherein the first monomer has the structure:



wherein M is a polymerizable backbone moiety,

wherein Z is a linking moiety comprising one of -C(O)O-, -C(O)-, -OC(O)-, -O-C(O)-C(O)-O-,
wherein Y is one of an alkylene group, an arylene, a semi- or perfluorinated alkylene group, and a semi- or perfluorinated arylene group,
wherein p and q are independently 0 or 1,
wherein R₁, and R₂ independently comprise one of hydrogen and a straight or branched alkyl group with 1 to 6 carbons,
wherein the resist polymer is soluble in an aqueous alkaline developer solution,

(B) selectively exposing a first portion of the resist layer to imaging radiation characterized by a wavelength such that a second portion of the resist layer is not exposed to the radiation, wherein the first and second portions of the resist layer form a pattern in the resist layer, wherein the radiation causes the acid generator to generate acid in the first portion of the resist layer, wherein the acid facilitates a chemical reaction between the resist polymer and the additive in the first portion of the resist layer such to generate a reaction product in the first portion of the resist layer, and wherein the reaction product is insoluble in the developer solution; and

(C) developing away the second portion of the resist layer by contacting the resist layer with the developer solution such that the second portion of the resist layer is replaced by voids in the resist layer.

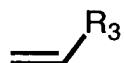
14. The method of claim 13, further comprising the steps of:

(d) transferring the pattern in the resist layer to the material layer, by etching into the material layer through the voids in the resist layer; and

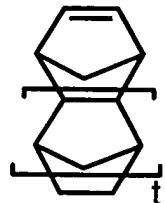
(e) after step (d), removing the resist layer.

15. The method of claim 13, wherein the wavelength is 193 nm or less.

16. The method of claim 13, wherein the polymerizable backbone moiety, M, includes one of an acrylic structure and a cyclic olefinic structure, wherein the acrylic structure is:



wherein R3 represents one of hydrogen, an alkyl group of 1 to 20 carbons, a semi- or perfluorinated alkyl group of 1 to 20 carbons, and CN, and wherein the cyclic olefinic structure is:



wherein t is an integer from 0 to 3.

17. The method of claim 13, wherein the resist polymer further comprises a second repeating unit formed from a second monomer, and wherein the second monomer has an aqueous base soluble moiety.

18. The method of claim 13, wherein Q comprises at least one alicyclic structure.
19. The method of claim 13, wherein the substrate comprises a semiconductor wafer.
20. The method of claim 13, said composition further comprising at least one of a solvent and quencher.